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PORTO RICO AGRICULTURAL EXPERIMENT STATION,
D. W. MAY, Agronomist in Charge,
Mayaguez, P. R.

BULLETIN No. 28.

Under the supervision of the STATES RELATIONS SERVICE,
Office of Experiment Stations, U. S. Department of Agriculture.

THE COFFEE LEAF SPOT
(Stilbella flavida)
IN PORTO RICO

BY

T. B. McCLELLAND, Horticulturist.

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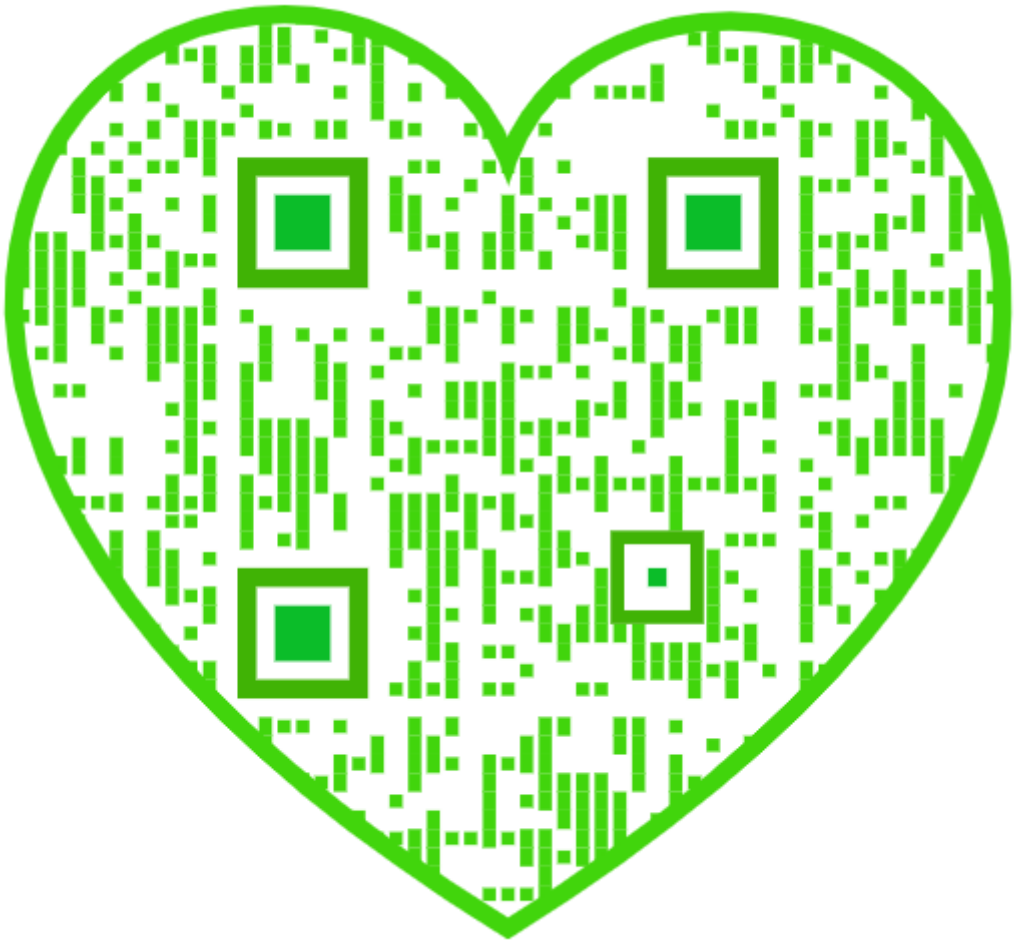

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[Under the supervision of A. C. TRUE, Director, States Relations Service, United States Department of Agriculture.]

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THE COFFEE LEAF SPOT (STILBELLA FLAVIDA) IN PORTO RICO.

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INTRODUCTION.

The purpose of this bulletin is to indicate means of controlling in the plantations of Porto Rico the coffee leaf spot (*Stilbella flavida*) (Pl. I), which is the cause of heavy and continuous losses to the coffee growers in Porto Rico, few of whom know anything of its nature, or are able to distinguish it from any other spotting of the leaves. The suggestions given for combating the disease are so simple that it is believed they may be easily carried out by any planter. There are many abandoned coffee lands in Porto Rico that doubtless can again be made to produce at a profit if the grower will follow the method outlined. The work required can be done, too, at a minimum cost and with very little effort. Many of the ravaged lands are not adapted to any other money crop at present, and, while the coffee industry is not in flourishing condition in Porto Rico, it is the most promising one for certain areas.

THE LEAF SPOT AND WHAT IT DOES.

The climatic conditions which seem most favorable for the growth of the coffee tree (*Coffea arabica*) also foster the development of the coffee leaf spot disease.

The disease is described in part by Fawcett[1] as follows:

> In Porto Rico it is found principally in the higher altitudes, where it is favored by excessive rainfall. Lower down it is found near streams and where it is sheltered from winds and afforded a moist atmosphere during part of the year. It is more dependent on moisture than other coffee fungi, being unable to infect new leaves or to form new fruits except under conditions of extreme humidity.

[1] Porto Rico Sta. Bul. 17 (1915), p. 11.

The disease is characterized by the occurrence on the leaves of small spots usually circular in outline, but sometimes ovoid along the veins. The newer ones are very dark, the older ones light colored. The spots are usually about 6 millimeters in diameter, although many of the older ones become 12 to 13 millimeters in diameter. Sometimes they fuse or give entrance to other tissue-destroying fungi which infect the intervening tissue, producing spots of considerable size. The worst affected leaves have from 30 to 40 or even more spots, so that a large proportion of the leaf tissue is destroyed. On the upper surface of many of the spots and also to some extent on the lower surface may be seen hairlike projections from 1 to 4 millimeters long of a yellowish color, each bearing at the end a head so that they resemble minute pins. This is the reproductive or fruiting stage of the fungus. Each spot produces a continuous crop of these hairs so long as weather conditions are favorable. The total number at any time is small, and in an entire season but from 20 to 50 are produced in each spot, judging from the number of old filament bases. The largest number observed was 70 in a spot of 7 millimeters diameter. As the leaf spots become older, growth having stopped for any reason, such as the advent of the dry season, the diseased tissue falls away, leaving numerous circular openings in the leaf. In other leaf diseases the dead tissue remains.

Sometimes the fungus attacks young stems, where it causes conspicuous scars and so weakens the points affected that they are easily broken by the wind. The berries also are attacked, a slight discoloration of the grain being frequently caused.

The microscope shows the filaments, which are solid, not hollow, as sometimes stated, to be made up of the fine fungus threads which are somewhat branched in the upper part to form the head. The ends of the threads are swollen and have sometimes been mistaken for spores when seen in cross section, and described as such. No real spores have ever been found in any of the numerous specimens examined. The fungus is distributed by the heads at the ends of the filaments being caught by the wind or raindrops and carried to near-by leaves, a process facilitated by the heads becoming loosened in the older filaments through the formation of cavities or "lacunæ" near the point of attachment. The head is soon fastened to the leaf on which it happens to fall by the numerous threads which it sends out at the point of contact. Within less than a week a dark circular spot is formed and new filaments appear, and new loosely attached heads are formed on these by means of which the spread of the disease is continued. Apparently this fungus has no other way of propagating itself, and the writer has not found any other stage of *Stilbella flavida*, all inoculations into coffee with suspected forms resulting negatively. * * *

The injury to the trees is not so much in the actual amount of the leaf tissue destroyed, although this may amount to one-fifth or even more of the entire amount of the worst cases, but in the defoliations which take place after a time. The diseased leaves drop sooner than those not affected, and owing to the weakened condition of the tree are not soon replaced. After the first severe attack the base of each tree may be seen to be surrounded by a pile of green leaves several inches deep. The disease never kills the trees. They live on with scanty foliage and are able to put forth some new growth and bear a small amount of berries each year.

The decrease in yield following an attack of the leaf spot is marked. In one experimental plat, where a record of the yield had been kept for some years, it was found to be 75 per cent. In this case the difference between the trees before and after the attack was such as accompanies the loss of the greater part of the foliage. * * *

FIG. 1.—A SPOT OF STILBELLA FLAVIDA ON COFFEE LEAF, SHOWING FRUITING BODIES. MAGNIFIED ABOUT FOUR TIMES.

FIG. 2.—A SPOT ON LEAF, SHOWING FRUITING BODIES OF STILBELLA FLAVIDA; B, ENLARGED HEAD OF FRUITING BODY OF STILBELLA FLAVIDA. [AFTER FAWCETT.]

FIG. 1.—STILBELLA-SPOTTED LEAVES DROPPED PREMATURELY.

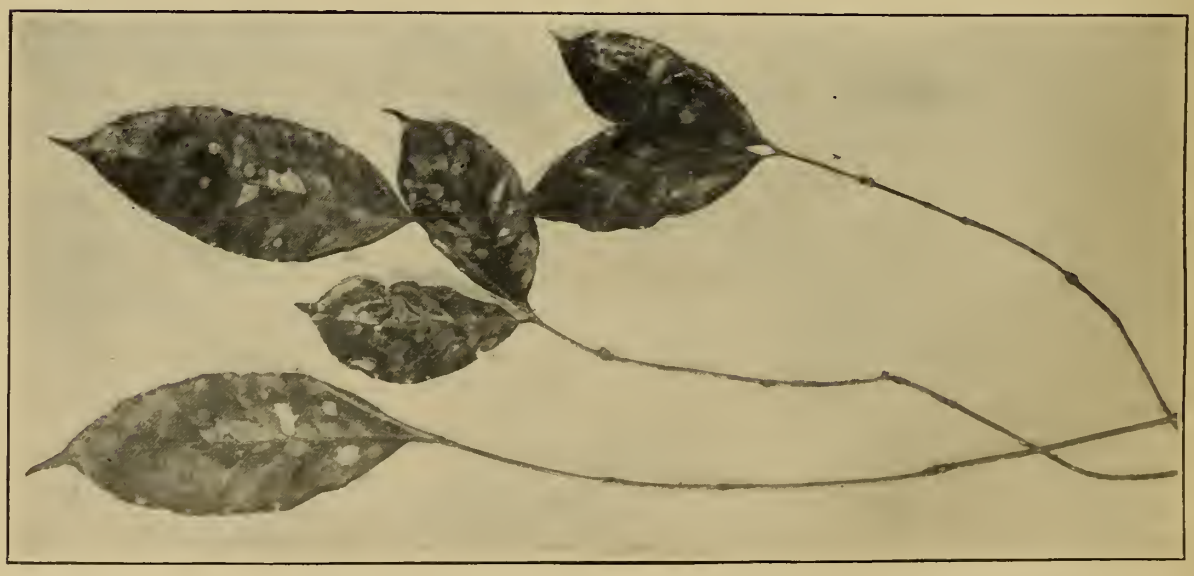


FIG. 2.—TYPICAL DEFOLIATION CAUSED BY STILBELLA, LEAVES REMAINING NEAR THE TIPS OF THE BRANCHES ONLY.

Such results as have been obtained would indicate that the disease might be successfully combated by removing the diseased leaves. No doubt the defoliation so produced is as bad for the tree as that caused by the fungus, but if the work were carefully done the newly formed leaves would remain free from infection, except as they might be gradually reached from trees outside the treated area. The fact that the disease spreads comparatively slowly and that the diseased leaves are readily recognized make this treatment more easily carried out. It would seem that this slow and apparently impracticable method might be really of value in combating the disease where the cheaper labor used on some of the plantations is available.

Spraying with Bordeaux mixture will exterminate the fungus if weather conditions happen to be favorable, but it is almost useless where the disease is most prevalent because of the frequent rains. The fungus can not infect leaves that are not moist much of the time; and when the leaves are dry, the time that Bordeaux would be most effective by adhering best, the disease is at a standstill, as any of the heads which happen to fall on such leaves do not germinate even if they adhere. The violent downpours soon wash the fungicide from the smooth upper surfaces of the leaves, where it must adhere to be of any effect. Moreover, the hillsides are so steep in many places that only knapsack sprayers could be used, and these only with difficulty. In case spraying is resorted to, it will be of most value when applied to the healthy trees near the diseased ones or to those less severely attacked, for the reason that the spray will prevent the infection of the leaves to which it adheres, though having no effect in preventing the formation of new propagative bodies on the already existing spots.

It is of interest to note that, although the coffee plant is the principal host of this fungus, numerous other plants are also affected to some extent. The writer has found it on such unrelated host plants as the orange, mango, Begonia, various ferns, several of the coitres (*Commelina* spp.), and guava (*Inga vera*), and bejuco de carro (*Velia sicyoides*), and have noticed the spots, but not fruits, on the yautia, banana, and also on several wild plants.[2] The coitres, which are perhaps most affected, and the ferns and other plants of low habit of growth form in many places a continuous ground covering and catch the greater part of the falling propagative bodies which escape the coffee leaves, and are hence peculiarly subject to the disease. They are apparently able to communicate it to unaffected plants of the same kind and doubtless also to healthy coffee plants. There were noticed places where the coffee was not attacked until several weeks after the ground plants had become infected.

A STILBELLA-INFECTED PLANTATION.

In 1916 the station was consulted in regard to a plantation which was said to have produced in former times betwen 300 and 400 quintals of coffee. For some unknown reason, however, its production became considerably smaller until in some years it did not exceed 10 or 12 quintals. A peon on the plantation reported the 1916 crop as 48 quintals and the 1917 crop as 28 quintals. The plantation, which is located in the heart of the coffee country on the slopes of one of the highest peaks of the island, was visited by the writer and found to be in an almost abandoned state; in fact, the condition was

[2] Porto Rico Sta. Bul. 17 (1915), p. 13.

such that the owner was willing to sell the place at $10 an acre. The coffee trees had at one time been enormous as was evident from their immense trunks. This clearly showed that the soil and climate were suitable for the production of coffee.

The spots of *Stilbella flavida* and the prematurely dropped green leaves were to be seen on all sides. (Pl. II, fig. 1.) It was quite evident that little could ever be expected from this coffee plantation on account of the continuous defoliation of the trees, which were in wretched condition. Their leaves and crops were borne mainly on high branches, and their long trunks were bare of lower limbs. (Pl. II, fig. 2.)

At the suggestion of the writer the owner agreed to cooperate with the experiment station by allowing a plat to be selected and handled under its direction to see what improvement could be made in the condition of the coffee. The plantation owner furnished the labor for the test. In order that several things may be understood in regard to the handling of this work, it should be explained that (1) there is no dwelling house on the plantation other than a hut in which the peon lives; (2) the owner lives at such a distance that it takes many hours in the saddle to reach the plantation, consequently he seldom, if ever, visits it, even to make an annual inspection; (3) the plantation is accessible by mountain trails only and is several hours distant from the nearest town and a day's journey from the experiment station; and (4) that only a few of the cheapest class of laborers are employed on the plantation, and they are changed frequently.

CLEANING OUT A DISEASED SECTION.

The initial work in eradicating the leaf disease from the selected plat of this coffee plantation was done under the joint direction of W. A. Mace, formerly agricultural technologist of this station, and the writer, both of whom remained on the plantation from January 30 to February 3, 1917. It was thought that the plat selected was approximately 3,400 or 3,600 feet above sea level, the altitude being estimated from a near-by point of known altitude.

The plat, while not an isolated one, offered some slight natural barriers against reinfection. The surface was steeply inclined, and two of the sides formed low convergent ridges. It measured 265 and 350 feet along the ridges, 90 feet along the upper boundary, and 313 feet along the lower boundary. Midway of the slope the plat was crossed by a footpath.

The stand of coffee trees in some parts of this plat was very good; in others it was very sparse. Above the footpath most of the land had been abandoned and was covered with underbrush which made

the process of clearing difficult and slow. Clearance was absolutely necessary, however, because the upper stand of coffee overhung the better stand. No regular coffee planting was found above the plat, but coffee trees were scattered among the wild growth.

As a first step in the work of eradicating the disease, the coffee trees within the plat were cut to stumps approximately 6 or 9 inches high, the larger wild growth was chopped down, and all the cut material was either burned or removed from the field. The ground was cleared as completely as possible of all miscellaneous living plants and the shade trees were cleaned of vines and epiphytic plants so that only the coffee stumps and the shade trees would be left in the plat. The clearing was made to overlap the ridges in order that these natural barriers might serve as much as possible to prevent reinfection. Personal supervision of the completion of the work was prevented by a labor strike, and it became necessary to leave to the peon in charge of the plantation the removal of scattered banana rootstocks and a large amount of the already cut growth from the central lower part of the plat. He was also instructed to set closely around the whole border three rows of banana trees to act as a barrier against the adjacent diseased coffee trees.

NUMEROUS HOSTS.

A thorough destruction of the miscellaneous growth in the plat was necessitated by the presence of a great number of plants which act as hosts to *Stilbella flavida*. Many of these plants were unknown to the men on the plantation.[3] Those found and examined included achiotilla, bálsamo, bejuco de mono, bejuco de paloma, berugillo, bruja, cadillos, camasey blanco, camasey cimarron, china, helecho, guasabára, guayaro, guava, higüerillo, lechecillo, lengua de vaca, moca, nuez moscada cimarrona, palo de cucubano, palo de hueso, tostado, vinagrera, yerba hedionda. Coffee seemed to be the favorite host, although there were several close seconds. It was found that a great many fruiting bodies developed from a single spot on the host plant bruja (*Bryophyllum calycinum*); and that moca (*Andira inermis*) should be avoided as shade for coffee, where the infection is to be cleaned out, because this tree may be a means of distributing the disease. The danger of infection from orange or guava (*Inga vera*) trees seemed slight. The orange trees were almost clean, and the guava trees, though showing numerous spots, bore only one fruiting body. Guamá (*Inga laurina*) seemed entirely free from infection and looked more vigorous than guava,

[3] The plants are, however, well known in Porto Rico and mention is made of them in order that the plantation owners may more readily know the host plants to be removed so that the disease can be combated.

for which this locality was apparently not well adapted. Many spots on banana leaves were examined to determine whether they were caused by Stilbella but in no instance was a fruiting body found.

OBSERVATIONS SUBSEQUENT TO CLEARING.

On March 27, 1917, the station wrote the plantation owners as follows:

> Destroy absolutely every green plant in the experimental plat excepting shade trees, old coffee, and the bananas planted around it. Small coffee seedlings should be destroyed because they are the most dangerous of all. It will probably be difficult to impress on the overseer the absolute necessity of getting rid of them.

On April 17, 1917, two and a half months after clearing, the plat was inspected. No recent cleaning had been done and weeds were growing up. With the exception of two or three leaves on a wild plant, which showed doubtful spots but no fruiting bodies, no Stilbella spots were seen. Shoots or renews from the coffee stumps were still very small, being only several inches high. On August 1, 1917, another request was made that the plat be cleaned. This was thoroughly done, and on August 21 the plat was inspected. The shoots from the coffee stumps were then from 1 to 3 feet high. More than 500 of them were carefully examined, but they showed no sign whatever of Stilbella.

In September the station sent to the plantation some coffee seed which the overseer was instructed to have planted at stakes in all vacant places. Instead of doing as directed, the overseer allowed the seed to be scattered closely in a small area.

Another cleaning was requested on January 12, 1918, and the third inspection was made on January 26. The plat was weedy, not having been recently cleaned. More than 350 coffee renews were examined, the whole plat, particularly the periphery being gone over very carefully. Only three trees, which were growing near the southwestern border, were found showing a few Stilbella-spotted leaves. At the end of a year less than 1 per cent of the trees showed any infection; that was only a slight one and near the edge of the plat where infection was to be expected. This showed the completeness with which this disease had been cleaned out. The diseased leaves were removed.

On August 10, 1918, a request was made that the plat be well cleaned, and on September 13 the fourth inspection was made. The plat had not been cleaned and needed it very much. The coffee renews appeared in excellent condition and had made good growth, an average tree being approximately 4 feet in height (Pl. III, fig. 1).

FIG. 2.—TWO YEARS' GROWTH FROM COFFEE STUMP.

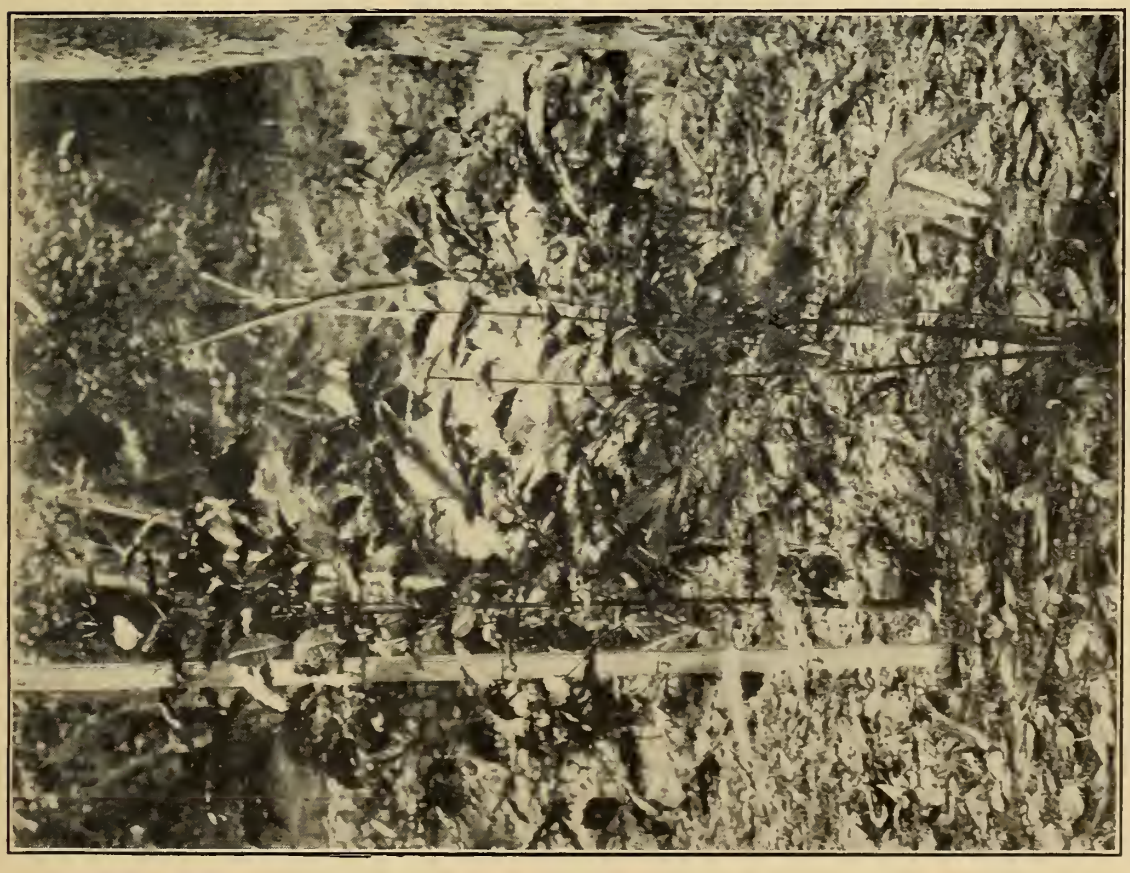
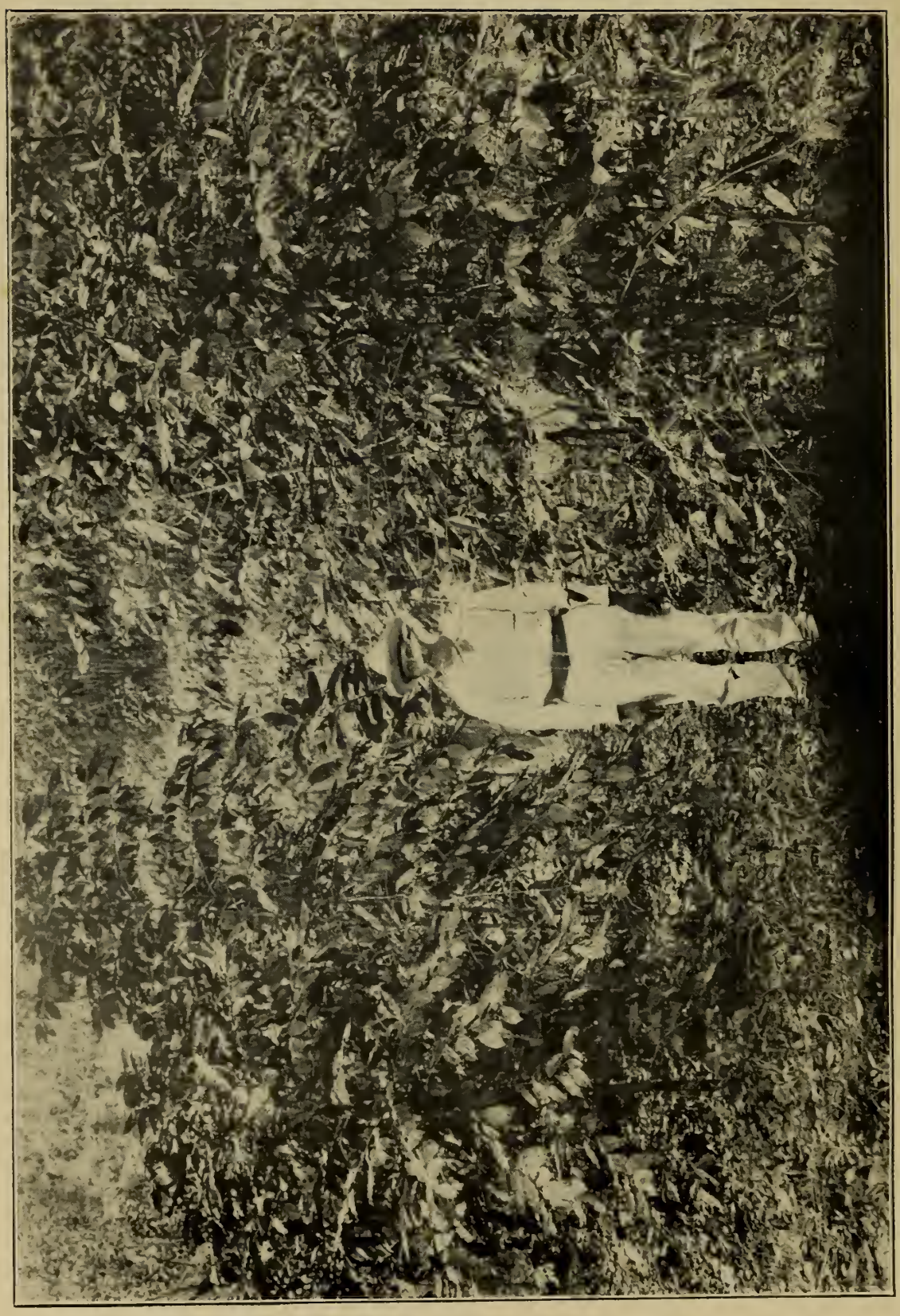


FIG. 1.—ONE YEAR'S GROWTH FROM COFFEE STUMP.



THREE YEARS' GROWTH FROM COFFEE STUMP.

More than 400 trees were examined and only 7, or less than 2 per cent, showed any infection. These seven were all near the southwestern border and the infections were slight. Where only several leaves were infected, they were removed; where a number were infected, the tree was cut down. As in little more than 19 months from the time of clearing absolutely no infection was found, except near the border where its reentry was to be expected because badly infected trees were near by, the elimination of disease through the original clearing of the plat was considered to be all that could be desired.

When the fifth inspection was made on November 12, 1919, the plat was found to need cleaning. The renews were in splendid shape and averaged approximately 6 feet high (Pl. III, fig. 2). Some of them were 9 feet or more in height. About four months prior to this date the overseer on his own initiative set some 600 or more young coffee trees throughout the plat below the path and a few above it at the west side. Many of these had been brought in from the diseased coffee outside the plat, and their leaves were riddled with Stilbella spots. Inasmuch as these trees had not only been carried through the planted area with every chance for thousands of fruiting bodies to drop and establish themselves on all sides but were allowed to remain there for some months as centers of infection, no further control over the disease could be expected to result from the original cleaning out.

The renews of more than a hundred coffee trees were examined with great care. Most of these were above the path where the overseer's replanting would not affect them, and some were below the path. With the exception of a single spot on one leaf, no other infection was seen on any of these. This tree was just below the path, into which its branches extended. Near it on both sides were young trees which the overseer had set. Below it was a small volunteer seedling which had one spot on one leaf. Some infection was observed in the V-shaped corner at the south where the wind was evidently bringing in fruiting bodies from the diseased plants outside.

During the first week in December, 1919, an attempt was made to clean out such disease as was visible, and a laborer who had worked for some years with the station pathologist was sent to the plantation. He reported 829 old trees in all. Of these, 695, or 83.8 per cent, showed no Stilbella spots; 75 trees, or 9 per cent, showed not more than two spotted leaves; and 59 trees, or 7.1 per cent, showed three or more spotted leaves. Of this last group, 12 trees were within 2 to 4 feet of the border of the plat. Above the path he found but two old trees which showed any infection and these were near the western border.

There were 610 young trees which had been set by the overseer. Of these, 254 showed Stilbella spots. On some seedlings every leaf was diseased. No spotted leaves were seen on the remaining 356 trees; it is probable, however, that the shock of transplanting, which is usually done by simply pulling up the seedling and setting it in elsewhere, added to the tendency already present of the diseased leaves to drop, had caused the loss of diseased leaves from many trees that now failed to exhibit evidence of infection.

Where not more than two spotted leaves were found on the old trees, the diseased leaves and those near them were removed. Where three or more spotted leaves were found the trees were cut down and removed. The young trees which showed spotted leaves were cut to 6-inch stumps, and all leaves were picked from the other young reset trees. The overseer was instructed to clean the plat of weeds and to keep it clean.

The sixth inspection was made on November 15, 1920. The plat was overgrown with grass and weeds of all sorts, and the overseer stated that he had no time to give to it. Though the coffee renews from the stumps had by no means attained full development they had made excellent growth. With the exception of the irregularity with which the trees were scattered, the plat presented the general appearance of a young plantation of very vigorous, healthy trees. Some of the trees showed remarkably fine development, being approximately 12 feet high and having a trunk the size of a man's wrist and branches that had as many as 15 nodes (Pl. IV). These trees were producing a pound of marketable coffee. A number of trees which were not so tall bore half a pound of coffee, and others bore still less. The production on the whole was fair. The new trunks with their branches from near the base up were a striking contrast to the old near-by unpruned trees with their high laterals; and the condition of the former for the production of the next crop far surpassed that of the latter.

No infection was found on the coffee trees which were in the central part of the section above the path where the overseer had failed to replant. Near and below it, where the diseased seedling trees had been carried in and planted for some months, many old trees showed no infection. However, on other trees scattered here and there some Stilbella-spotted leaves were found. In some instances only several leaves out of many hundred showed disease spots, whereas on others approximately a third of the branches bore spotted leaves. Naturally reinfestation was to be expected as the result of the thorough inoculation given by the overseer some 16 months before. Reinfestation was also furthered through the presence on the weed-covered land of many host plants, which conveyed the leaf disease from one coffee tree to the next.

RECOMMENDATIONS FOR CONTROLLING STIBELLA.

The degree of control which was maintained over this disease under very adverse circumstances demonstrated that it could be handled easily by destroying the host plants and after that by maintaining a quarantine.

If Stilbella is to be controlled on an infected area the work will be simplified by first establishing clean cultivation. This can be done by weeding the area frequently. There should be little or no difficulty in keeping weeded a section that is heavily shaded by the coffee and shade trees. After the grass and weeds have been killed, the coffee trees should be cut away 6 inches above ground and the stump left with a clean diagonal cut which will shed the rain. This should be done as soon as the crop has been removed, so that full advantage can be taken of the dry season. The felled trees may be chopped up just where they fall. The control of the disease depends on the thoroughness with which the host plants are destroyed. Any careless overlooking of diseased plants may mean speedy reinfection of the coffee. Subsequent work consists in keeping the coffee and adjacent areas free from weeds which may harbor the disease, and also in maintaining a sharp lookout for reinfection in order to remove any disease as soon as it appears.

In vicinities where conditions are favorable to Stilbella, coffee trees that have long been severely affected would be greatly improved were they cut to a low stump and forced to develop a new trunk. In the experiment discussed in this bulletin two entire crops, most of a third, and possibly part of a fourth crop were lost through felling the coffee trees. If maintained free from disease the new growth should soon yield more than enough to compensate for this loss of crop from the old diseased trees.

Good results are much more certain to follow where all Stilbella-infected sections of a plantation are cleared in the same season than where some sections are left to be worked over later. On many plantations this can be done. Where, for economic reasons, it is impracticable to work over the whole diseased area in one season, the most isolated and the most elevated sections affected should be cleaned first in order to leave no diseased tracts overhanging the cleaned ones. All natural barriers, such as ridges, uninfected plantings of food crops, or pasture land, should be taken advantage of; and where no natural barriers exist, a strip of coffee may be destroyed along the edge of the section to be cleaned and rows of bananas planted closely enough to offer a barrier against the diseased plants outside. Care should be exercised to reduce to a minimum the passing of pickers and laborers from diseased into disease-free sections.

As long as disease is present on the plantation the coffee grower will have to exercise diligent and unremitting care to produce healthy coffee. As soon as it is noticed that disease has reentered a cleared section immediate steps should be taken to eradicate it. This can be done either by picking off the diseased leaves and those near and below them or by destroying the branches or even the tree and near-by growth, depending upon the degree of infection.

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